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Amendments to the Specification

Please amend the paragraph before the title of the invention on page 1, line 1 as follows:

~~SPECIFICATION~~

~~TITLE OF THE INVENTION~~

Please amend the sub-heading on page 1, line 7, as follows:

~~Field of the Invention~~

1. Field of the Invention

Please amend the sub-heading on page 1, line 13, as follows:

~~Description of the Related Art~~

2. Description of the Related Art

Please amend the paragraph on page 1, line 14, as follows:

As optical information recording mediums capable of recording/reproducing a signal by means of a laser light, there exist a phase change type optical disc, a magnetic optical disc, a dye disc and the like. Among those discs, in the phase change type optical disc which is capable of recording/erasing a signal, a typical material to be used for a recording layer is chalcogenide. Generally, the recording layer is regarded as an unrecorded state when the material for the recording layer is in a crystal state. A signal is recorded on the recording layer such that the recording layer material is irradiated with a laser light to be melted ~~melt~~ and quenched so as to come into an amorphous state. On the other hand, in the case of erasing a signal, the recording

layer material is irradiated with a smaller power laser light than at the time of recording, so as to come into a crystal state. Since the recording layer comprising chalcogenide is formed while in the amorphous state, it is necessary to previously crystallize the whole surface of the recording region to obtain an unrecorded state. Such crystallization of the whole surface of the recording region is called initialization.

**Please amend the paragraph on page 2, line 10, as follows:**

As a technique for realizing high density of the recordable/erasable phase change type optical disc, it has been proposed to use a blue laser light having a wave length of about 410 nm as a light source for recording/reproduction in place of a conventionally commonly used red laser light, to increase the numerical aperture of an objective lens of an optical system, which applies the laser light for recording/reproduction onto the optical disc, from the conventional commonly used numerical aperture of 0.60 to about 0.85, thereby reducing the size of a laser light spot. It has also been proposed that, in the case of using the objective lens with the numerical aperture thereof made as large as 0.85, a transparent protective substrate on the laser light incident side have a smaller thickness, such as 0.1 mm, than the 0.6 mm thickness of the substrate of an already commercialized DVD-RAM, for the purpose of securing tilt tolerance of an optical information recording medium in terms of recording/reproduction characteristics (e.g., ~~eg~~-cf. Japanese Patent Laid-Open Publication No.10-154351).

**Please amend the paragraph on page 3, line 5, as follows:**

Further, as a technique for multiplying a recording capacity per face, a medium with a single-sided multi-layered configuration has been proposed (e.g., ~~eg~~-cf. Japanese Patent Laid-Open Publication No. 2000-036130). Moreover, a technique concerning production of a substrate of an optical disc having a guide groove on the surface thereof is also known (e.g., ~~eg~~-cf. Japanese Patent Laid-Open Publication No. 09-320100).

**Please amend the paragraph on page 3, line 13, as follows:**

However, the experiments performed by the present inventors revealed the following as follows. In the single-sided multi-layered phase change optical disc which performs recording/reproduction by means of a blue laser light, on the information layer on the side closer to the laser light source, a noise level of the disc after recording especially in the outer perimeter region degrades as compared with the inner and the middle perimeter regions. The cross section of this disc was observed with a transmission electron microscope, to find that the guide groove itself has an almost symmetric shape with respect to the center thereof over the whole region from the inner perimeter to the outer perimeter of the disc, thus having no particular problem. However, in the outer perimeter region of the disc, there was recognized a remarkable difference, e.g., about 20%, in thickness of the information layer between an inclined face portion on the inner perimeter side and an inclined face on the outer perimeter side of the guide groove.

**Please amend the paragraph on page 5, line 24, as follows:**

Almost all those ~~the~~-skilled in the art form a thin layer constituting an information layer by placing a substrate and a target so as to be mutually opposed and then ~~performing sputtering is performed~~, and the present inventors also form the thin layer in this manner. It is difficult to employ other methods for the layer formation from the perspective of convenience and practicability of a layer forming device and a layer forming rate. Generally, since recording by means of a laser light is performed by forming a mark in the guide groove and/or a flat portion between the guide grooves, the layer forming device is designed so as to keep the layer thickness uniform in the flat portion from the inner perimeter region to the outer perimeter region of the disc. However, as for the inclined face of the guide groove, an angle and a rate of particles flying by sputtering from a target as a raw material of the layer are not uniform from the inner perimeter region to the outer perimeter region of the disc. This causes some portions of the inclined face

on the inner perimeter side and the inclined face on the outer perimeter side of the disc to have different thicknesses by the shadowing effect. However, since no mark is formed on the inclined face of the guide groove, and the inclined face has thus been considered to exert no direct influence on the recording/reproduction characteristics, an attempt has not been made to keep the layer thickness uniform with high accuracy between the inclined face portion on the inner perimeter side and the inclined face portion on the outer perimeter side of the guide groove over the whole region from the inner perimeter region to the outer perimeter region of the disc.

**Please amend the paragraph on page 7, line 12, as follows:**

In order to solve the above-mentioned problems, an optical information recording medium of the present invention comprises one or more information layers including a recording layer for recording/reproducing an information signal by irradiation with a laser light, and a separating layer or a protective substrate on which a first information layer of the information layer on the irradiation face side is formed. The formed, the separating layer or the protective substrate ~~having has~~ a guide groove spirally or concentrically formed on the surface, and the respective inclined planes on the inner perimeter side and the outer perimeter side of the guide groove ~~having have~~ inclined angles  $\alpha$  and  $\beta$  with respect to the bottom face of the guide groove. ~~The groove,~~ the guide groove ~~having has~~ one or more dissymmetric regions where the inclined angles  $\alpha$  and  $\beta$  are different.

**Please amend the paragraph on page 8, line 15, as follows:**

Further, as the optical information recording medium of the present invention, one can be used in which the dissymmetric region consists of a ~~first~~first and second dissymmetric regions, and has a relation:  $\alpha - \beta \leq 10$  degrees in the first dissymmetric region, and a relation:  $\alpha - \beta \geq 20$  degrees in the second dissymmetric region.

Please amend the paragraph on page 10, line 11, as follows:

The optical information recording medium of the present invention can be produced using the following method, for example. Namely, it is a method for producing an optical information recording medium comprising one or more information layers including a recording layer for recording/reproducing an information signal by irradiation with a laser light, and a separating layer or a protective substrate on which a first information layer of the information layer on the irradiation face side is formed. ~~The formed, the separating layer or the protective substrate having~~ has a guide groove spirally or concentrically formed on the surface, and the respective inclined planes on the inner perimeter side and the outer perimeter side of the guide groove ~~has having~~ inclined angles  $\alpha$  and  $\beta$  with respect to the bottom face of the guide groove. ~~The groove, the~~ guide groove having has one or more dissymmetric regions where the inclined angles  $\alpha$  and  $\beta$  are different. ~~The different, wherein the protective substrate is formed by molding with a stamper as~~ a mold produced from a master, and as the master, one is used which has a dissymmetric region where the inclined angles  $\alpha$  and  $\beta$  are different.

Please amend the paragraph on page 11, line 24, as follows:

Fig. 1 is a schematic sectional view showing one example of a configuration of an optical information recording medium according to a first embodiment ~~Embodiment 1~~ of the present invention.

Fig. 2 is a sectional view of ~~an one constitutional example showing one example of a~~ configuration of an optical information recording medium according to a second embodiment ~~Embodiment 2~~ of the present invention.

Fig. 3 is a schematic sectional view showing ~~an one example of a~~ configuration of an information layer to be used for the optical information recording medium of the present invention.

Fig. 4 is a schematic sectional view showing ~~an one example of another~~ configuration of

an optical information recording medium according to the second embodiment ~~Embodiment 2~~ of the present invention.

Fig. 5 is a schematic view showing an ~~one~~ example of a ~~constitution of a~~ recording/reproduction device used for the optical information recording medium of the present invention.

Fig. 6 is a schematic view showing one example of a pulse waveform for use in recording/reproduction of the optical information recording medium of the present invention.

**Please amend the heading on page 12, line 24, as follows:**

~~DESCRIPTION OF THE PREFERRED EMBODIMENT~~

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

**Please amend the paragraph on page 14, line 14, as follows:**

An optical information recording medium according to the present embodiment has a one-sided multi-layered configuration as shown in the schematic sectional view of Fig. 2. This recording medium has two information layers which are a first and second information layers. The second information layer 8, the separating layer 7 and the first information layer 2 are sequentially laminated on the protective substrate 3.

**Please amend the paragraph on page 16, line 2, as follows:**

The lower side dielectric layer 10 and the upper side dielectric layer 14 are provided for the purposes including prevention of evaporation of the recording layer or thermal transformation of the substrate when recording is repeated, and further, enhancement of a light absorption coefficient and an optical change of the recording layer by the optical interference effect. As the material for the lower side dielectric layer 10 and the upper side dielectric layer 14, a dielectric

material having excellent heat resistance, or the like, is used. For example used can be an oxide of Y, Ce, Ti, Zr, Nb, Ta, Co, Zn, Al, Si, Ge, Sn, Pb, Sb, Bi or Te, a nitride of Ti, Zr, Nb, Ta, Cr, Mo, W, B, Al, Ga, In, Si, Ge, Sn or Pb, a carbide of Ti, Zr, Nb, Ta, Cr, Mo, W or Si, a sulfide of Zn or Cd, selenide, telluride, a fluoride of rare earth such as Mg, Ca or La, a simple substance such as C, Si, Ge or a mixture of these. Above all, a substantially transparent material having low thermal conductivity, e.g. ~~eg.~~ a mixture of ZnS and SiO<sub>2</sub>, is preferred. For the lower side dielectric layer 10 and the upper side dielectric layer 14, different materials with different compositions may be used according to need or the same material with the same composition can also be used.

**Please amend the paragraph on page 16, line 24, as follows:**

The lower side interface layer 11 and the upper side interface layer 13 are provided in contact with the recording layer 12 for the purposes including promotion of crystallization of the recording layer 12, improvement in erasing characteristic, and prevention of mutual diffusion of atoms/molecules between the recording layer 12 and the lower side dielectric layer 10, and/or between the recording layer 12 and the upper side dielectric 14 so as to improve durability in the repeated recording. Further, the lower side interface layer 11 and the upper side interface layer 13 are required to have environmental reliability, like giving a rise to peeling from or corrosion with the recording layer 12. Some of the materials cited above ~~ited~~ as the material for the lower side dielectric layer 10 and upper side dielectric layer 14 can serve as a material for the lower side interface layer 11 and the upper side interface layer 13. For example, a nitride based upon Ge, Si or the like, an oxide of Ti, Zr, Hf, V, Nb, Ta, Cr, Mo, W or Si, a composite oxide of these can be used. Above all, a material obtained by adding an oxide of Cr, Mo or W to an oxide of Ti, Zr, Hf, V, Nb or T as a base is excellent in terms of moisture resistance, and moreover, a material obtained by adding an oxide of Si to the above-mentioned base can further increase an erase rate. The respective thicknesses of the lower side interface layer 11 and the upper side interface layer 13 are not particularly restricted. However, the effect as the interface layer cannot be exerted

when the layer thickness is too small, while recording sensitivity is lowered or the like when the layer thickness is too large, and hence the preferable thickness of each of the lower side interface layer 11 and the upper side interface layer 13 is for example not less than 0.2 nm and not more than 20 nm. Although the above-mentioned effect is exerted even by arrangement of either the lower side interface layer 11 or the upper side interface layer 13, arrangement of both interface layers is more preferred. In the case of arranging both the layers, different materials with different compositions may be used according to need or the same material with the same composition can also be used. When the upper side interface layer 13 is used, the upper side dielectric layer 14 can be omitted, and in such a case, the thickness of the upper side interface layer 13 is preferably from not less than 2 nm and not more than 50 nm.

**Please amend the paragraph on page 18, line 18, as follows:**

The recording layer 12 can be broadly classified into a rewritable type and a recordable type. As a rewritable recording layer 12 suitably used is a phase change recording material, namely a material mainly composed of a chalcogen material of Te and/or Sb. Above all, a material system obtained by mixing compositions of two compounds, ~~compound~~, GeTe and Sb<sub>2</sub>T<sub>3</sub>, in an appropriate rate is preferred since a crystallization rate is high and a recording/reproducing characteristics can readily be held even when the layer thickness is made smaller for ~~increasing a~~ increasing transparency. In order to increase the crystallization rate of this material system, part of Ge can be replaced with Sn, or part of Sb can be replaced with Bi, and it is further preferable to use a composition expressed by a general formula: (Ge<sub>x</sub>Sn<sub>1-x</sub>)<sub>z</sub>(Sb<sub>y</sub>Bi<sub>1-y</sub>)<sub>2</sub>Te<sub>2+z</sub> where 0.5 < x ≤ 1, 0 ≤ y ≤ 1, z ≥ 1. With x ≥ 1, a reflectance and a change in reflectance can be made large. For the purposes including adjustment of a crystallization rate, thermal conductivity, an optical constant or the like, or improvement in repetition durability, heat resistance or environmental reliability, the above-mentioned material composition may be appropriately added with one or more elements selected from metals such as In, Ga, Zn, Cu, Ag, Au, Cr, additional metals such as Ge, Sn, Sb, Bi and Te, semimetals or semiconductor elements,



and nonmetal elements such as O, N, F, C, S and B, according to need, in the range not larger than 10 atomic %, or more preferably not larger than 5 atomic %, of the total composition of the recording layer 12.

**Please amend the paragraph on page 20, line 16, as follows:**

Further, as a recordable recording layer 12, for example, an inorganic material such as a phase change recording material based upon a metal having a relatively low melting point, like Te, Sb, Bi, Sn, In or Ga, or a metal oxide, or an organic material such as dye. Among them, a material based upon Te oxide is suitable for the recordable recording layer since it allows ~~allowing~~ nonreversible crystallization recording, and is also suitable for a recording layer to be used for a translucent information layer since it makes ~~making~~ it easier to realize a high transparency. For example, a material mainly composed of Te, O, and M (M is one or more elements selected from Al, Si, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, Zr, Nb, Mo, Ru, Rh, Pd, Ag, In, Sn, Sb, Hf, Ta, W, Re, Os, Ir, Pt, Au and Bi). The most preferable ones as the element M are Pd and Au. With these elements added, a crystallization rate is improved so as to secure high environmental reliability.

**Please amend the paragraph on page 21, line 8, as follows:**

This material preferably has a composition containing O atoms in the range not smaller than 25 atomic % and not larger than 60 atomic %, and M atoms in the range not smaller than 1 atomic % and not larger than 35 atomic %. With the O atoms less than 25 atomic %, the thermal conductivity of the recording layer may become excessively high, resulting to result in an extremely large recording mark. This makes it difficult to increase the C/N ratio even if recording power is raised. As opposed to this, with the O atoms exceeding 60 atomic %, the thermal conductivity of the recording layer becomes excessively low, resulting to result in an insufficiently large recording mark even if recording power is raised. This thus makes it difficult

to realize a high C/N ratio and high recording sensitivity. With the M atom less than 1 atomic %, an action to promote growth of Te crystals becomes relatively small at the time of irradiation with a laser light, ~~resulting to result in~~ an insufficiently low crystallization rate of the recording layer 12. This prevents formation of a mark at a high rate. As opposed to this, with the M atom exceeding 35 atomic %, a change in amorphous-crystal reactance may decrease to lower the C/N ratio. Further, for the purposes including adjustment of thermal conductivity or an optical constant, or improvement in heat resistance or environmental reliability, the above-mentioned material composition can be appropriately added with one or more elements selected from nonmetal elements such as N, F, C, S and B, according to need, in the range not larger than 10 atomic %, or more preferably not larger than 5 atomic %, of the total composition of the recording layer 12.

**Please amend the paragraph on page 22, line 21, as follows:**

When the above-mentioned recordable recording layer 12 has a thickness of not less than 2 nm and not more than 70 nm, and more preferably not less than 4 nm and not more than 30 nm, a sufficient C/N ratio can be obtained. With the thickness of the recording layer 12 being too thin, a sufficient reflectance and change in reflectance cannot be obtained, ~~resulting to result in~~ a low C/N ratio. With the thickness of the recording layer 12 being too large, heat diffusion in the thin layer of the recording layer 12 is excessively large, ~~resulting to result in~~ a low C/N ratio.

**Please amend the paragraph on page 23, line 16, as follows:**

The transparency adjusting layer 16 is provided for the purpose of increasing a transparency while a change in reflectance of the first information layer is kept high. As a material for the transparency adjusting layer 16, ~~layer 16 used can be~~ a translucent material having a high refraction index can be used, e.g., a material mainly composed of  $\text{TiO}_2$ ,  $\text{Bi}_2\text{O}_3$ ,  $\text{Nb}_2\text{O}_5$ ,  $\text{ZrO}_2$ ,  $\text{HfO}_2$ ,  $\text{Ta}_2\text{O}_5$ , or a mixture of these. Above all, a material mainly composed of  $\text{TiO}_2$  is most preferred since it has ~~having a~~ refraction index of about 2.7.

**Please amend the paragraph on page 24, line 9, as follows:**

As for the separating layer 7, an ultraviolet ray-curable resin or the like can be used. In order that, when one of the two information layers adjacent to the separating layer 7 is reproduced, a cross talk from the other information layer is made small, the separating layer 7 needs to have a thickness at least not smaller than a focal depth determined by the numerical aperture (NA) in the objective lens 6 and a wavelength ( $\lambda$ ) of the laser light 5, and further, each of the information layers needs to have a thickness within a light collectable range. For example, the thickness of the separating layer 7 needs to be not less than 10  $\mu\text{m}$  and not more than 100  $\mu\text{m}$  when  $\lambda = 660 \text{ nm}$  and  $\text{NA} = 0.6$ , and needs to be not less than 5  $\mu\text{m}$  and not less than 50  $\mu\text{m}$  when  $\lambda = 405 \text{ nm}$  and  $\text{NA} = 0.85$ . However, if an optical system capable of reducing a cross talk between layers is developed, the thickness of the separating layer 7 may be made thinner than the above-mentioned thicknesses.

**Please amend the paragraph on page 25, line 12, as follows:**

Each of the above-mentioned thin layers can be formed for example by a phase thin layer deposition method, such as vapor deposition, sputtering, ion-plaiting, CVD (Chemical Vapor Deposition), or MBE (Molecular Beam Epitaxy). Above all, sputtering is preferred since it is

being practical from the aspect of the layer formation rate and the device cost.

**Please amend the paragraph on page 26, line 18, as follows:**

However, when the inclined angle of the guide groove is made small, the quality of a tracking error signal obtained from the guide groove deteriorates. For suppressing the deterioration in tracking error signal quality, it is effective not to merely make the inclined angle small, but to make the inclined angle small only in the inclined face portion, where the thickness of the information layer is conventionally small, which is either the inclined face portion on the inner perimeter side or the inclined face portion on the outer perimeter side of the guide groove. The present inventors have found that, in the outer perimeter region of the optical disc, the thickness ( $d_2$  in Fig. 1) of the information layer in the inclined face portion on the outer perimeter side of the guide groove tends to be smaller than the thickness ( $d_1$  in Fig. 1) of the information layer in the inclined face portion on the inner perimeter side. In the outer perimeter region, reduction in thickness of the information layer in the inclined face portion can be suppressed by making the inclined angle small on the outer perimeter side of the guide groove. The inclined angle on the outer perimeter side is preferably made smaller than the inclined angle on the inner outer-perimeter side, by an angle difference of 20 degrees or larger, and more preferably 25 degrees or larger. This has permitted effective suppression of the noise increase in the outer perimeter region.

**Please amend the paragraph on page 30, line 11, as follows:**

Fig. 5 shows a schematic view of one example of a configuration, consisting of minimum essentials of a recording/reproduction device for performing recording/reproduction, of the optical information recording medium according to the present invention. The laser light 5 ~~emitted~~ ~~departed~~ from a laser diode 17 is focused through a half mirror 18 and the objective lens 6 on an optical information recording medium 20 being rotated by a motor 19. This reflected light is incident on a photo detector 21 to detect a signal.

**Please amend the paragraph on page 34, line 1, as follows:**

A polycarbonate sheet was bonded to the surface of the first information layer, using an ultraviolet ray curing resin, to form a transparent substrate having a thickness of 75  $\mu\text{m}$ . Subsequently, this disc was annealed with a laser light from the transparent substrate side, while being rotated, to initialize the whole surface of the recording layer in each of the information layers.